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EDITOR, C. A. CHANT ASSISTANT EDITOR, F. S. HOGG

David Dunlap Observatory
Richmond Hill P.O., Ont.

ASSOCIATE EDITORS:

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Dominion Astronomer
Ottawa

J. A. PEARCE
Dominion Astrophysicist
Victoria, B.C.

A. THOMSON
Controller of the Meteorological Service of Canada, Toronto

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Visitors to Toronto who wish to get in touch with the Society are invited to telephhone:

General Secretary—Mr. E. J. A. Kennedy, EL. 7656.
Assistant Secretary—Mrs. E. Todd, KIng. 3419.
Society Headquarters—3 Willcocks St.

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THE JOURNAL
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THE UNIVERSE—WHENCE?*

by J. W. CAMPBELL

Introduction

MY subject may sound pretentious. Men have long been interested in various phases of evolution of the physical universe, but these phases have been mostly the evolution of limited systems. Thus we have had theories of the origin and evolution of the solar system, and more generally of the evolution of individual and binary stars.

For example, Laplace's hypothesis on the origin of the solar system started with an extensive, rotating, gaseous mass and it gave a theory of how this mass evolved into the solar system. The planetesimal hypothesis of Chamberlin and Moulton started with the near approach of two stars and gave a picture of how one of the stars could be torn by the tidal waves produced by the other, and of how this torn star with its scattered fragments would evolve into our solar system after the disrupting visitor had passed on in its journey into the depths of space. In stellar evolution the Russell-Hertzsprung diagram shows stars distributed in terms of absolute magnitude and spectral type, and one interpretation is that it suggests a life cycle for stars; on this interpretation it suggests that the giant red stars are stars in their early stage, that the evolution

*Address by the retiring president of the Royal Astronomical Society of Canada, at the Annual At-Home, in Toronto, on January 14th, 1949.

from that stage is one of increasing temperature to the blue stage, and then a decline through decreasing brightness and temperature towards the last stages.

But all of these theories start with a going universe. Laplace presupposed a rotating nebula and suggested no source for it. Chamberlin and Moulton pre-supposed a universe of suns in motion relative to one another, and gave no suggestion of whence they came. Russell interpreted his scatter-diagram as a picture of stars in various stages of their life cycles, but he gave no suggestion as to how the giant red stars arose. In fact, I once heard Russell remark, in a small group where his diagram was being discussed, that when he started with giant red stars he was, so to speak, "standing on Atlas"—he had no theory for what went before.

It is my purpose in this paper to deal with this more general problem. One finds various references to it in the literature, but the statements made indicate a lack of agreement. And I do so, not with the suggestion that a definite answer can be arrived at, but rather with the aim of bringing into clearer relief some of the difficulties involved in the problem.

Beginnings

There is perhaps a natural tendency for the average person to think of the universe as having a beginning, and the conceptions of it have been expressed in various forms. For example, we read in the first chapter of Genesis "In the beginning God created heaven and earth . . . .". And while there are few who will claim that the story in Genesis is one of scientific accuracy, it is of interest to consider its setting. It reflects the concept of the past as it appeared to the early Hebrew writers, and there is a certain naturalness in the ideas expressed when it is remembered that a scientific background was lacking. But the story dates from a time which is actually relatively recent. For when the Hebrew culture was in its infancy Egypt had a civilization whose inception was already ancient. The Mosaic law was received two thousand years later than the time when Cheops built the pyramids at Gizeh. Also, the light which we see to-day when we look at the Adromeda nebula had completed ninety-nine percent of its journey to the earth centuries before those pyramids were built.

In fact the idea of a creation is not a simple one to conceive. The average man probably does not think very clearly, if at all, about the problem. On the other hand Moulton considers some aspects of it rather thoroughly in the early chapters of his book *Consider the Heavens.* He points out an interesting psychological fact, viz., that men are willing to accept as plausible reports from distant places or from the remote past, which they would reject as unreasonable if attributed to places nearby or to times in the recent past. Men have, and justifiably so, a strong confidence in the dependability of nature, and stories of entirely irregular behavior do not receive ready credence.

The alternative to the idea that the universe was created at some epoch in the past is the idea that the universe has not had a beginning, or in other words, that the universe has always existed. Either concept is, of course, difficult to imagine, but we shall consider them in turn. An to this end it is useful to have in mind some of the properties of the system as we know them today.

Some Properties of the Universe

First, our sun belongs to a system of thousands of millions of similar bodies which constitute our galaxy. They are the stars, a few of which we see on a cloudless night; they occupy a watch-shaped region of space with our sun at a place considerably removed from the centre, the diametral plane being in the plane of the milky way; the region is about five thousand light years in thickness, and its diameter is roughly ten times as great.

And this is just one galaxy. Telescopes reveal other similar galactic systems. In fact, the concept we now have is that of thousands of millions of galaxies, each consisting of thousands of millions of suns, their distances apart being hundreds of thousands of light years.

Every star of this vast aggregation moves within the confines of its own galaxy, and the galaxies move relative to each other. Also, every luminous star pours forth a flood of radiant energy. Some slight appreciation of the enormousness of the energy which is poured out in this way is possible by considering our own sun. On personal standards we are struck by the magnitude of the rate at which the earth receives heat from the unclouded sun at noon-day,

but one readily realizes what a minute fraction of the sun's radiated energy is intercepted by the earth. One therefore gets a little idea of the stupendous outpouring of the energy by the sun. And in the whole aggregation of the universe our sun is only one of thousands of millions of similar bodies. Also, it is a very modest representative, for compared with the average it is low in performance. Many of the stars radiate at rates which are hundreds and thousands of times as great as the rate of radiation of our sun.

When one stops to reflect on what is happening the picture is an arresting one. Thousands of millions of millions of suns pouring out energy at a prodigious rate! Not only are they doing so now, but they have done so for millions of years and the indications are that they will continue to do so for millions of years to come. Two questions strike one forcibly: what is the source of all the energy and what is its destination?

Second, there is our modern concept of time and space.

In pre-relativity days time was regarded as an absolute entity whose flow was unaffected by other phenomena. This concept was suggested by Newton's enunciation that "absolute, true and mathematical time, of itself and from its own nature, flows equally without regard to anything external, and by another name is called duration". But relativity indicates that space and time are not independent, and that the old concept of an absolute and universally uniform flow of time is untenable.

Suppose an observer O, equipped with a clock, observes an object at position $(x.y,z)$ in the system $O.xyz$ at time t. Then the combination of position (x,y,z) and time t constitutes an event which may be expressed as (x,y,z,t). A neighboring event is $(x + dx,\ y + dy,\ z + dz,\ t + dt)$, and the separation ds of the events is given by

$$ds^2 = c^2dt^2 - dx^2 - dy^2 - dx^2, \tag{1}$$

where c is the velocity of light.

A second observer O', with coordinate system $O'.x'y'z'$ and a clock showing time t', would observe the same separation of these two events, but to him it would appear as

$$ds^2 = c^2dt'^2 - dx'^2 - dy'^2 - dz'^2. \tag{2}$$

The quantity ds is called the world interval, or proper time

interval, between the two events, and it is the same for all observers.

Now if O considers O' as the observed object the two events can be expressed as (x,y,z,t) and $(x + dx, y + dy, z + dz, t + dt)$, and hence

$$ds^2 = c^2dt^2 - dx^2 - dy^2 - dz^2. \tag{3}$$

But when O' considers himself as the observed object the two events are $(0, 0, 0, t')$ and $(0, 0, 0, t' + dt)$, and hence

$$ds^2 = c^2dt'^2 \tag{4}$$

If we put $dq^2 = dx^2 + dy^2 + dz^2$, then from (3) and (4) we have

$$c^2dt'^2 = c^2dt^2 - dq^2 = c^2\left(1 - \frac{v^2}{c^2}\right)dt^2,$$

$$dt' = \sqrt{1 - \frac{v^2}{c^2}}\, dt, \tag{5}$$

where is the velocity of O' with respect to O.

That is, O observes O'' sclock to run at a slower rate than his own. But from the symmetry of equations (1) and (2) it follows that we can also deduce that as seen by O', O's clock will appear to run at a slower rate than O''s.

Again suppose a rod, of length l when at rest in $O.xyz$, is moving with its length in the direction of O''s motion and so as to be at rest in $O'.x'y'z'$. The velocity of light is the same with respect to either, and if a light signal travels to and fro over the rod the time taken as seen by O' will be $2l/c$ while the time taken as seen by O will be

$$\frac{l'}{c - v} + \frac{l'}{c + v}$$

Therefore by (5)

$$\frac{2l}{c} = \sqrt{\left(1 - \frac{v^2}{c^2}\right)}\ \left(\frac{l'}{c - v} + \frac{l'}{c + v}\right),$$

whence

$$l' = \sqrt{1 - \frac{v^2}{c^2}}\, l, \tag{6}$$

That is, as seen by O and measured by light signals, the length of a rod moving with O' appears shortened in the ratio $\sqrt{1 - v^2/c^2}$, when the rod has its length in the direction of motion. Likewise it can be shown that if the rod is transverse to the direction of

motion there is no apparent change in the length. Also, as seen by O', a rod at rest with respect to O appears shortened or unaltered in exactly the same ratio.

It is interesting to reflect on the significance of these contraction properties. Are they real or apparent? In this regard there is an important distinction between the two contractions.

The length contraction is apparent only while the motion lasts. The appearance is real then, but there is no physical effect and the appearance vanishes when rest is resumed.

With time, however, the effect is different. The appearance is not only real but it is accumulative. When two observers separate and meet again the times elapsed may or may not agree. The contractions are reciprocal and equal oppositely only so long as the motion is uniform, but if O and O' separate and meet again there must be a stage of non-uniform motion (relative acceleration). A suitable discussion shows that if $O.xyz$ is an inertial frame and O' experiences the acceleration then when they meet again O will have experienced more time than O', and the time distortion is real.

Moreover, if $O.xyz$ is an inertial frame with O not in the vicinity of ponderable matter, and if O' is distant r from a mass m and moving with a velocity v with respect to O, then the time of O' as compared with the time of O is distorted by the relation

$$dt' = \left(1 - \frac{v^2}{2c^2} - \frac{m}{r}\right) dt, \tag{7}$$

where the units are so chosen that the constant of gravitation is unity in magnitude.

It is to be noted that (7) reduces to (5) when $m = 0$ or $r = \infty$, and v is small with respect to c. Also, from (7) it follows that the time-rate is slowed down not only by relative motion but also by the mere presence of matter.

The universe that we look out upon has thus a more intricate character than we had anticipated.* Dimensions of bodies in

*The picture would be made more intricate were we to introduce the red-shift of distant nebulae, the simplest explanation of which is the concept of the expanding universe. It would also be made more intricate if we were to include a description of nuclear reactions as revealed by modern physics. But the issue between a finite and an infinite past is probably more clearly drawn by the properties already referred to, than by an inclusion of these two phenomena.

motion appear distorted but the distortion is an appearance only. Time flow on bodies in motion is likewise distorted. Distortion of time flow too is apparent, but it is also accumulative and the accumulated effect may be an actual increase or decrease. There is no longer a universal *now* for all observers. A configuration that is simultaneous for one observer will not be simultaneous for all other observers. This is one of the facts to be kept in mind when considering theories of origin and development.

We return now to the ideas of the past of the universe.

A Finite Past

In *The Nature of the Physical World* A. S. Eddington, later Sir Arthur, devoted considerable space to a discussion of this problem. To him, in this connection, the second law of thermodynamics was of supreme importance apparently, and its significance he represented somewhat in this manner.

The second law of thermodynamics implies that the random element in the organization of the universe increases with time. The practical measure of the random element which can increase but not decrease is called entropy, and therefore increase of entropy is a necessary accompaniment to the passage of time.

In this connection he stated:

> Entropy continually increases. We can, by isolating parts of the world and postulating rather idealized conditions in our problems, arrest the increase, but we cannot turn it to a decrease. That would involve something much worse than a violation of an ordinary law of Nature, namely, an improbable coincidence. The law that entropy always increases—the second law of thermodynamics—holds the supreme position among the laws of Nature .... If your theory is found to be against the second law of thermodynamics I can give you no hope, there is nothing for it but to collapse in deepest humiliation.

And later he wrote:

> Travelling backward into the past we find a world with more and more organization. If there is no barrier to stop us earlier we must reach a moment when the energy of the world was wholly organized with none of the random element left in it .....
>
> There is no doubt that the scheme of physics as it has stood for the last three quarters of a century postulates a date at which either the entities of the universe were created in a state of high organization, or pre-existing entities were endowed with that organization which they have been squandering ever since."

But while Eddington regarded the second law of thermodynamics as the supreme guide in assessing any theory of development, he recognized the dilemma to which it leads, and he wrote:

> As a scientist I simply do not believe that the present order of things started off with a bang; unscientifically I feel equally unwilling to accept the implied discontinuity in the divine nature. But I make no suggestion to evade the deadlock.

An Infinite Past

Another point of view was suggested by W. D. MacMillan in a paper entitled *On Stellar Evolution.** His suggestion arose from an endeavor to resolve two great questions to which we have already referred:

1. What becomes of the enormous flood of energy which is poured forth so lavishly by the sun and by the stars?

2. What is the source of the enormous subatomic energies which have been revealed by the radioactive elements, and which by implication exist in all of the elements?

The second of these questions has long received attention, especially as it applies to our sun, but the former has received little or no consideration.

But as MacMillan has pointed out, "an infinite source or an infinite sinkhole is scarcely to be thought of", and the two questions are just two aspects of a common problem.

MacMillan does not give to the second law of thermodynamics the pre-eminent place assigned to it by Eddington. In fact he postulates that, in some way which we do not understand, from the great flood of radiation in space there may be re-condensations to atoms and molecules, and that by condensations of these atoms and molecules, stars may be developed. In defence of this waiving of the second law of thermodynamics he points out that our intimate knowledge of the predominance of this law is confined to a small region of the universe and that it is not impossible that the law is not everywhere true. Whether this is an acceptable position or not is a matter of opinion, and it does not admit of proof.

According to MacMillan's idea, therefore, a star may grow by the accretion of matter or decrease by the radiation of energy.

*Astrophysical Journal, Vol. 48, 1918, pp. 37-49.

The stars will ebb and flow and the evolution of the system is not a one-way process. In the concluding paragraph of his paper he wrote:

> There is no necessary limit to its age, and though the star itself may rise and fall, the universe as a whole is not essentially altered. The singular points (masses) may change their positions and their brilliancy, but it is not necessary to suppose that the universe as a whole has ever been or ever will be essentially different from what it is today.

We have thus two opposing views as to the nature of the evolution of the universe. One view, favored by Eddington, pictures the universe as proceeding on a one-way evolution—from a state of high organization to a state of low or vanishing organization. The other view, favored by MacMillan, pictures the universe as in a state of constant surge, but without a predominant trend in one direction.

Let us examine more closely what is implied by each of these theories.

Comparison of Theories

As already stated, Eddington pointed out that, according to the law of increasing entropy, "travelling backward . . . . we must reach a moment when the energy of the world was wholly organized with none of the random element left in it." But how does the random element increase? Well, one of the ways is by radiation. Hence if we picture a time when the world was "wholly organized" then we picture a time when no radiation had taken place.

A state of perfect organization is not so simple to visualize, however. How far back would one go to a state of no radiation, to the time when the energy was at the surface of a star or to the time when the energy was still at some interior position? Also, on what time system would the time of zero radiation occur? In accordance with relativity there is no universal Now, as already pointed out, and hence if to one observer all the stars appeared to start radiation simultaneously, then to other observers they would not so appear.

Eddington said he simply did not believe that the universe started off with a bang in a state of high organization. Such an abrupt discontinuity would be antithetical to the orderly processes of nature in which we have been led to believe, but we see also that it is difficult to visualize even if we overlook its improbability.

If we postulate the second law of thermodynamics as a fundamental law, we have a working hypothesis for a period that does not extend too far back in the past and an hypothesis that encounters no contradictions for the future. On the other hand it leads to an ultimate impassee in the past.

Consider, now, the alternate theory. MacMillan pictures evolution as a two-way process. To quote:

> Important consequences follow the admission that atoms are built up in this manner (from the condensation of radiant energy). It would follow that space contains much material of atomic or even molecular dimensions, and that regions long undisturbed by stellar objects would tend to become more or less crowded with atoms and molecules on account of the ceaseless passage of radiant energy through it. .

There is in this picture no dead alley of discontinuity. One is not led back to an ultimate beginning nor forward to an ultimate end. It is true that freedom from contradiction has been achieved at the cost of assuming that the second law of thermodynamics does not hold universally, but in this connection MacMillan observed:

> According to Kapteyn the average distance of the first magnitude stars is 75 light years. We have a right to be cautious in extending our hypothesis of . . . the transmission of radiant energy into regions in which 75 light years is the unit of distance.

Eddington was not unmindful of this possibility for he wrote:

> Is there no counter-process by which radiation collects in space, evolves into electrons and protons, and begins star-building all over again? . . . . I would mildly criticize the mental outlook which wishes it to be so.

Personally, I do not think this a fair suggestion. Having known MacMillan intimately I cannot believe that he was indulging in wishful thinking. On the other hand I feel certain that, having all the facts available before him, he was formulating a theory which he believed embodied the least amount of difficulty in totality.

Summary:

When we look out to-day on the universe we see a going mechanism. We observe a prodigious transformation taking place, a tremendous outpouring of energy. We have a satisfactory theory for the source of the energy but we have none for its destination.

We observe the system to be in a state of intricate relative motion, and relativity tells us that there is no absolute time in terms of which the evolution of the system can be described. This fact makes it difficult to attach any meaning to the specification of a designated condition at some epoch in the past.

Within the range of our experience there is one law that has held without exception—the second law of thermodynamics. This law means that energy transforms in the direction of decreasing organization of the whole, and that, in particular, heat does not flow of its own accord from a colder to a hotter body.

If we regard this law as of supreme importance then the evolution of the universe is a one-way process, and this in turn involves the occurrence of an abrupt start (creation) at some epoch in the past. But such an occurrence is also wholly contrary to experience, and moreover, in view of the observed properties of the system, it is difficult to ascribe any meaning to such an occurrence.

On the other hand, if we do not regard the second law of thermodynamics as universally supreme we are not faced with the difficulty of contemplating a sudden discontinuity (creation) in the past.

In considering the indefinitely remote past of the universe, therefore, we are involved in difficulty in any case. If we regard the second law of thermodynamics as supreme then we have to accept the difficult idea of an abrupt beginning, and if we regard the idea of an abrupt beginning as untenable then we must regard the second law of thermodynamics as not universally true.

Both ideas are difficult of conception, and neither one can be proved. The choice of which he prefers must be left to the judgement of each individual.

There is one aspect of the problem worth noting, however. The occurrence of an abrupt creation would constitute a negation of the law of continuity, whereas the assumption of the non-universality of the second law of thermodynamics may imply only a modification of that law and not its rejection. For more than two centuries the Newtonian law of gravitation was regarded as a supreme law of nature. Now, however, its truth is modified, but not rejected, by the theory of relativity.

• • • • • •

Three teen-age boys on a winter afternoon were out in the country playing together. They came to the edge of a level clearing covered with fresh snow and they decided to have a competition—they would walk to the other side of the clearing and see which one could trace out the straightest path. They did so, and at the conclusion they compared notes.

One boy said he kept his eyes on his feet and endeavored to put his new foot prints in a line with the ones he had just made. The second said he noticed the first boy doing this, and he also noticed that his path was not quite straight. So he endeavored to straighten his own path by allowing for the errors the first boy was making. But the third by said he looked neither at the other two nor at his own feet. Instead he picked out a distant tall tree and made directly for it; and he was the winner!

The moral of this story has an astronomical counterpart in the maxim: "Better to set your course by the distant stars, than by the passing ships".

INTERNATIONAL ASTRONOMICAL UNION, 1948

By A. Vibert Douglas

THE seventh General Assembly of the International Astronomical Union took place from August 11-18, 1948 in the magnificent Swiss Federal Institute of Technology in Zurich. The setting was perfect. Swiss hospitality and efficiency in planning are unbounded, and Zurich has almost everything—a lake, two rivers running through the city, hills within and around the city, historic buildings, many narrow steep cobbled streets, here and there a square or triangular *platz* with a fountain or heraldic statue adorning it, a cloistered minster with traditions dating back to Charlemagne, and several smaller churches with famous clock towers; broad modern avenues, schools, colleges, research laboratories, hotels, pensions, shops, museums, and a funicular to the new residential sections high up above the lake.

Some 300 astronomers from 32 countries had gathered to renew scientific and friendly contacts, to discuss the progress in their specific fields, record achievements and difficulties, delineate new problems, and plan further cooperation.

The largest delegation was from Great Britain (about 44 astronomers), closely followed by France and the U.S.A. with 42 listed from each. There were three Canadian delegates, the Dominion Astronomer, the Director of the Dominion Astrophysical Observatory and the writer. Dr. Beals was named chairman of the Finance Committee of the I.A.U. A fourth name appearing in the list from Canada was that of a temporary resident of this country, Mlle. van Dien of Holland now on the staff of an observatory in the Dutch East Indies.

Moving about from commission to commission, from seminar to informal lunch or tea, from formal banquet to lake or mountain excursions, from a music recital at the minster to an occasional casual ramble through the old picturesque streets, one talked with many an old friend and new acquaintance. One's thoughts were continually being carried back to similar groups in other days in other surroundings. Seven of us who had met in Montreal in August 1932 preparing for the total solar eclipse met again in Zurich—Herbert Dingle, F. J. M. Stratton, J. A. Carroll, G. Abetti of Arcetri, Canon Lemaître

of Louvain, S. A. Mitchell of Virginia. Seven of us, representing five nationalities, had met at Yerkes Observatory in the summer of 1925. Four of us had dined as guests of Miss Vinter Hansen at Copenhagen Observatory in early June and the previous week I had met another four at Leiden University. There were the Greenwich friends, and those from Cambridge, from Oxford, from Harvard and Mt. Wilson. There was John Jackson all the way from the Cape of Good Hope and he carried my thoughts to Greenwich in 1923 and to Boston in 1932 when we laughed together over the bicycle pump at Greenwich which had succeeded in reducing the pressure in a Shortt Clock case to a certain minimum value that was afterwards found by Loomis with elaborate apparatus and thoroughness to be the optimum pressure. Many astronomers were conscious of missing faces—ten years can thin the ranks and among the great scientists whom the I.A.U. mourned were Eddington, Jeans, A. Fowler, R. H. Fowler, E. Strömgren and Deslandres.

The I.A.U. operates through commissions, each assigned to specific tasks, and usually several of these groups were simultaneously at work.

As summaries of the proceedings and reports have appeared in *Observatory* (Vol. 68, No. 846), *Nature* (Vol. 162, No. 4127), *Sky and Telescope* (Vol. 7, No. 12), I shall restrict myself to those commissions and seminars which I attended with special interest.

The Commission on Solar Radiation was presided over by Dr. Abetti. Much discussion centred upon the variations reported, confirmed and unconfirmed, in the solar constant and in the solar field. Regarding the former, indirect and somewhat conflicting, evidence from observations on the moon, Jupiter and Saturn were reported—variations of about three per cent. may be present and more observations were urged of the total energy, the ultraviolet and in the radio range. As to the magnetic field, a recent determination gave 5 gauss; but here, too, inability to repeat readings, and the apparent occasional or perhaps periodic disappearance of the field call for fresh methods of attack on this problem. Öhman suggests detection of circular polarization of solar radio waves from one polar region at a favourable partial eclipse.

The Commission on Extragalactic Nebulae showed a geographic alignment of observational astronomers vs. theoretical investigators.

The cosmologists, McVittie in particular, urged the importance of publication of data corrected only for standard instrumental and "local" effects. Only thus could such data be used to test one theory of world structure against another. Hubble, Stebbins and Shapley presented the observational evidence. Hubble commented on the tendency for the galaxies to be in clusters, and the pressing need for stellar magnitude sequences for red and blue stars and for investigation of the effect of red shift upon apparent magnitude. Stebbins gave evidence of increased reddening with distance which might imply intergalactic matter or a higher proportion of red supergiants in the more and more remote past corresponding to our knowledge of the more and more distant galaxies. Shapley produced some evidence of the uniqueness of our galaxy from the high luminosity of our great globular clusters, and he repeated his warning that the open spiral may be a forerunner of the elliptical galaxy rather than a later development from it.

A masterly report on spectrophotometry was presented by Minnaert. In the meeting of this Commission 36, Struve summarized many recent investigations such as: CO_2 in the atmosphere of Venus of an amount equivalent to 50 metre-atmosphere; reflected sunlight from the moon and Mars resembles that from brown igneous terrestrial rock; reflections from Martian polar caps is not like that from solid CO_2, but resembles that from H_2O frost deposited on a very cold surface; green areas of Mars reflect not as from chlorophyl, but as from dry moss and lichens; Saturn's rings and five inner satellites may be composed of ice.

In Commission 29 some important contributions were: Ramberg on the spectra of the Hyades; Vyssotsky on the *G* stars and *G* band; Beals on the molecular spectra of Wolf-Rayet, *C* and *N* stars, parallel sequences of which one group shows no nitrogen but bands due to carbon and oxygen, whereas the other group has no carbon but contains bands due to helium and nitrogen, high ionization indicating temperatures of 70,000 to 100,000 degrees though these Zanstra estimates are subject to some questioning.

A symposium on the abundance of elements was a high point. Minnaert opened the three and a half hour session with a discussion of solar absorption line problems; Minnaert's table of relative abundances in the sun was compared with Menzel's values for planetary

nebulae, Strömgren's values for interstellar matter and Unsold's values for T Scr. Hoyle discussed the Mass-Luminosity relations applicable to stars from 0.5 to 1.5 times the sun's mass. His conclusion that main sequence stars, in spite of the steady drain on their hydrogen by the energy-producing cycle, are still composed predominantly of hydrogen is in direct line of succession to Eddington's pioneering in this field a quarter century ago.

Then followed a stimulating paper by Klein on the origin of the isotopes of elements in their observed relative abundances. The pioneers in this investigation were Chandrasekhar and Heinrich about ten years ago. They postulated a tremendously dense and hot concentration of all the matter of the universe in the form of elemental or nuclear particles, and statistical equilibrium conditions resulted in a distribution of isotopes of the lighter elements very closely in agreement with observation, but the method broke down for the heavier elements. Klein and his associates postulate stars of nuclear matter with central temperatures of 10^{10} degrees and show that the relative abundances necessary for statistical equilibrium are in good agreement with the actual distribution.

The last contribution was a masterly review by Struve of challenging problems presented by the spectra of certain stars. He referred especially to Pearce's mighty giant binary, most massive star known, whose sharp Bq spectrum shows emission lines and also some stark effects, anomalies which make it "a very important star".

It is tempting to go on and on as the mind dwells on other meetings—Shapley on an International Observatory and Laboratory with Unesco cooperating; Stratton on exchange of astronomers and the need for travel and maintenance funds, which led the writer to draw attention to the C.C.R.U. study and research fellowships and to urge some astronomers to apply for these and spend a year at a Canadian observatory; Ambarzumian, one of seven U.S.S.R. astronomers, discussing the effects of interstellar matter in relatively small clouds having random distribution in the galactic plane; the demonstration of Lyot's polarizing filter on the sun (though this observer did not see a flare); the exciting films of solar prominences and infalling gases taken at Climax, Arizona.

My personal interest in Eddington's *Fundamental Theory*, published under that title after his death, led me to seek expressions of

opinion from many of the astronomers at the congress. I found few who had taken pains to study it seriously, and only one, Canon Lamaître, who is so sure of its basic importance that he is working upon it himself. He was greatly impressed with an exerpt from a letter of Eddington's which I quoted, and which I repeat here because of its intrinsic interest (see J.R.A.S.C., Vol. 38, No. 3, 1944, p. 98) "I think the theory now deserves to be the accepted theory—my definition of an 'accepted theory' being that it is the theory that is so far right that everyone is interested in trying to discover what is wrong with it". Apropos of this, it may be of interest to refer here to a chance meeting at a lunch at Christ Church, Oxford, in July with Professor Whittaker of Liverpool University. He is a mathematician and son of Sir E. T. Whittaker who took all Eddington's manuscripts and prepared *Fundamental Theory* for the press. Both father and son believe that, though parts of the theory are unconvincing in Eddington's presentation and though his train of thought is often obscure, nevertheless time and further research will vindicate his depth of insight and establish the essential truth and fundamental importance of his last contribution to knowledge.

There is nothing static about astronomy, and to meet new demands the I.A.U. has revived the Commission on Celestial Mechanics and formed new commissions on Radio Astronomy, on History of Astronomy, and on Photometric Double Stars.

Sir Harold Spencer Jones has been succeeded in the presidency by Prof. Lindblad of Sweden; and Dr. J. H. Oort of Leiden, the capable and untiring secretary, has passed this responsibility to the broad shoulders of Dr. Strömgren of Copenhagen.

To the Council of the Royal Astronomical Society of Canada which named me a delegate to the 1948 I.A.U. Congress my thanks are herewith expressed with sincerity and appreciation. In a world where there is much political and economic distrust, it is heartening to find scientists of many nations meeting as friends, planning together for the advancement of their science, reducing to a minimum their nationalisms and petty differences, and placing integrity in research above all else.

Queen's University,
Kingston, Ontario,
February 15, 1949.

CHANT MEDAL PRESENTATION

At the Annual Meeting of the Royal Astronomical Society of Canada, on January 10th, 1949, the award of the Chant Medal to Miss Isabel Keith Williamson, of Montreal, was announced. The actual presentation of the medal was made to Miss Williamson at the At-Home of the Society on January 14th, at Toronto.

In the absence of Professor Kingston, the Chairman of the Chant Medal Committee, the report of the committee was read by Mr. Kennedy, the General Secretary. In accepting the medal Miss Williamson gave a very interesting brief talk, in which she emphasized the pleasure she had, during the past eight years, in her study of astronomy. She also paid tribute to the co-operation she had received from her fellow-members in Montreal, in the pursuit of extensive and successful observing programmes.

From the document submitted by the executive of the Montreal Centre, the following exerpts are taken:

Miss Williamson has been one of the mainstays of this Centre since she first joined the Society in 1941, and it is no exaggeration to say that the present flourishing condition of the Centre is due in large measure to the amazing amount of time, energy and enthusiasm she gives to our affairs. Following are some of the important activities of the Centre, the success of which is due almost entirely to Miss Williamson's efforts:

Star Nights—These are open air meetings which we hold occasionally, to give the public an opportunity for observation. Our last Star Night, held last May, attracted some 3,000 persons to Westmount Park where twenty-three telescopes were available for observation, and lectures on the constellations and other objects were given over a public address system. The extremely complicated organization of this event, involving as it did some ninety of our members, was planned and directed by Miss Williamson.

Saturday Night Observation Meetings—These meetings are held every Saturday evening throughout the year, and include telescopic observation when possible, informal talks, quiz programmes, etc. Miss Williamson usually plans and prepares the programmes, sometimes gives talks and generally provides the necessary drive to make the meetings successful. For several years she has scarcely missed a Saturday meeting.

"Skyward"—During 1948 the Centre commenced publication of a monthly mimeographed bulletin entitled "Skyward", containing news items, announcements and jottings regarding our activities. Miss Williamson voluntarily assumed editorship of this valuable paper, and now has the onerous job of collecting and editing the material, cutting the stencils and attending to the mailing. With our membership of nearly 300, this is no small task.

Asteroid Club—The Asteroid Club is an original idea of Miss Williamson's and its purpose is to provide an incentive for children of members to learn the stars. When a child knows ten celestial objects he is given a prize and a red star. As he learns to identify more objects he is awarded an orange star, and so on through the spectral sequence. Miss Williamson devotes considerable time to conducting the tests, keeping records, preparing the prizes and generally encouraging the youngsters.

Practical Observing—It is undoubtedly in the field of practical observations that Miss Williamson has made her greatest contribution to astronomy. Due mainly to her efforts, the Montreal Centre is making regular observations in several fields, to an extent unequalled by any amateur group in the Dominion. Her particular interests lie in the study of meteors and of the aurora. In this connection, Dr. Gartlein of Cornell University, leading authority on the aurora, has stated that her aurora reports have not been equalled by any group in a large city, while Dr. Millman has said that the meteor observations made under her direction—particularly the Giacobinid shower of 1946—provided the most valuable information obtained from any group, amateur or professional.

While the activities detailed above are the highlights of Miss Williamson's work, she has also contributed to the spread of astronomical knowledge in many other ways. As recording secretary of the Centre her reports of lectures and minutes of meetings have always been models of what such records should be, she has been a conscientious and hard-working member of almost every committee appointed by the Council, she has occasionally delivered formal lectures at our regular meetings, and she has somehow found time to grind and complete an excellent 6-inch reflecting telescope.

(J. W. Duffie, *President, Montreal Centre*)

Under Miss Williamson's guidance the Montreal Centre of the Society has consistently turned in meteor observations, both visual and photographic, which are of the highest quality. The most outstanding single effort was made at the time of the great Giacobinid shower of 1946 when over two dozen of the Montreal members of the Society were organized by Miss Williamson as a team and carried out a programme of observation of these meteors. This work was so carefully coordinated, and the scientific method was so accurately followed, that the results from these observations give us, in my estimation, the most reliable information we have concerning the densities of meteoric matter in the centre of the Giacobinid swarm. I consider that the Giacobinid observations of the Montreal Centre are the outstanding example of meteor observations planned and carried out by amateurs for the purpose of producing scientific results of value.

(Peter M. Millman, *Dominion Observatory*)

MINUTES OF THE ANNUAL MEETING OF THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

The fifty-ninth annual meeting of the Society was held in the McLennan Laboratory, University of Toronto, on Monday, January 10th, 1949, the President, Dr. J. W. Campbell presiding.

The minutes of the last annual meeting were read and adopted.

Scrutineers—Messrs. Sherrick and Crook, with Mrs. Todd, the Office Secretary, were on motion appointed Scrutineers, and were given permission to retire for the counting of the ballots.

Reports—The General Secretary, General Treasurer, Librarian and Assistant Editor presented their reports for 1948. These appear in the JOURNAL.

Chant Medal—The General Secretary stated that the Chant Medal was being awarded this year to Miss I. K. Williamson, of Montreal, and that the presentation will be made at the annual At-Home.

Discussion—Considerable discussion took place regarding members in arrears. The Secretary said these are now being checked more carefully than in previous years. There emerged from the discussion the suggestion that a letter might be issued from the office pointing out to delinquents that the JOURNAL and HANDBOOK, to say nothing of administration expenses, cost the Society considerably more than the annual fee; therefore it is desirable that the fees should be paid promptly. . . . Following the Librarian's report, a resolution of thanks was given to the Toronto Centre for their kindness in having the Cooke telescope repaired, at a cost to them of $95.00. . . . Mr. Andrew Thomson congratulated the Editors of the JOURNAL on the publication of articles in French from time to time. These are greatly appreciated by the members of our two French Centres.

Election—The scrutineers reported that 367 ballots had been cast and that 306 of these were for the slate as submitted by the Council, while the remaining 61 contained slight variations. The President, therefore, declared the slate elected.

Number on Council—Mr. Kennedy pointed out that under Article V of the Constitution provision is made for only twelve elective Council members, whereas we have now fourteen Centres;

and it would seem desirable that each Centre should have a representative on the Council in addition to its President. He therefore moved, seconded by Dr. Best, that we recommend to the Council that steps be taken to amend the Constitution to overcome this difficulty. Carried.

Change of Name—It was also suggested that the name "General Council" should be changed to "National Council," or "Dominion Council." A test vote was taken, with the result that only one preferred to continue as General Council, none voted for Dominion Council, while fifteen preferred National Council. It was thereupon moved, seconded and carried that reference similar to that in the preceding paragraph should be made to the Council.

Resolution to Dr. Kingston—Information having been received that Dr. H. R. Kingston, of London, had met with a painful accident a few weeks ago, as a result of which he is still in the hospital, it was moved by Mr. Thomson, seconded by Dr. Best, that the sympathy of the Society be extended to him, with the hope that he may soon be completely recovered.

Thanks—A resolution of thanks to the Officers for their services during the past year was submitted by Mr. Dale, and carried.

The meeting then adjourned.

H. W. BARKER, *Recorder*.

REPORT OF THE GENERAL SECRETARY

Judging by the enthusiasm shown in the reports of the fourteen centres detailing their varied activities, 1948 will be regarded as a most successful year. The main objective of our Society is to promote a continued interest in the science of astronomy and to introduce the subject to those who have not yet enjoyed the pleasure of knowing the wonders of our universe. We think, therefore, that the aims of the Society are being well carried forward.

Although astronomy may be classed as one of the profound subjects, many of its features are as attractive to the amateur as to the learned. In addition to the pleasure members receive from increasing their knowledge of the beauty of the heavens, they can take pride in the thought that the General Society is filling an increasingly important place in the cultural development of Canada.

The David Dunlap Observatory was made possible by the generosity of a one-time member of the Society under the influence of Prof. Chant. As an amateur Society we acknowledge the very great assistance we receive from the professionals who have made astronomy their life work.

It is not necessary in this report to list the many important results of our observations and work. These are all incorporated in the attached reports of each centre. Particular mention could be made, of course, of the interesting programme of work from the Montreal Centre with the assistance of their very fine telescope in the Ville Marie Observatory.

Attached is the list of our increasing membership which gives a total now of 2,016. You will notice that Montreal shows a decrease over the previous year, but this is accounted for by the fact that a new centre came into being, namely, Centre Français de Montrèal. This centre commenced in the fall of 1947 and is comprised of French speaking members. With one exception the centres show an increase for 1948. We are urging the centres to clear their membership lists and not to carry past due members. It has been suggested that six months be time allowed before members are stricken from the list.

We are very pleased to announce that the interest in the Chant Medal contest is reviving and Miss I. K. Williamson, recording secretary of Montreal Centre, is the winner for 1948. Miss Williamson will be at the At-Home when the presentation will be made to her.

Miss E. M. Budd who has been the Office Secretary for the long period of 36 years retired on the 1st of December last. The thanks of the Society goes to her for long and faithful service. Mrs. E. Todd is her successor.

The General Council has had the burden of solving our financial stringency. After determined efforts on the part of the Treasurer with the help of the centres, we were unsuccessful in inducing the government to increase our grant. The Council thereupon reluctantly raised the fees to $3.00 per year. With this increase we are hoping to have enough to systematize our office system so that there will be a more efficient carrying forward of the work of the Society from the secretarial standpoint.

Membership on December 31, 1948	1947	1948
Toronto	291	334
Ottawa	69	80
Hamilton	47	58
Winnipeg	34	35
Montreal	283	270
Victoria	92	127
London	28	38
Vancouver	56	47
Edmonton	40	58
Quebec	97	76
Windsor	58	72
Saskatoon	35	35
Guelph	75	96
Centre Français de Montréal	30	48
Members unattached to Centres		
Canada	130	84
United States	325	331
Other countries	40	34
Life Members not included in Centres	23	28
Subscribers	65	90
University of Toronto	75	75
	1893	2016

E. J. A. Kennedy, *General Treasurer.*

Report of Librarian

During the year 1948 the following number of periodicals were received:

Canada and the Empire	69
United States of America	63
Other Countries	55
	187

The number of books loaned from the shelves was 159

Expenditure for new books, none. Expenditure for binding periodicals, none.

Back numbers of the Journal of the Society have been sent to several of the observatories in Europe in response to their request.

The Toronto Centre very kindly offered to bear the expense of certain repairs and improvements to the General Society's four-inch Cooke refracting telescope which is now in excellent condition and is fully at the disposal of the General Society for the use of members. Thanks are due to Mr. G. F. Longworth for his able assistance in this work.

D. W. Best, *Librarian.*

REPORTS OF SECRETARIES OF THE CENTRES

Toronto Centre

During 1948 the Toronto Centre secured 80 new members; nearly half of these were elected at the first autumn meeting, having been enrolled as a result of our public Star Nights during the summer on the University of Toronto campus, and our telescope display at the Canadian National Exhibition.

In addition to 11 regular meetings, four public Star Nights were arranged on the University campus and on May 28 a special Members' Observation Night was held in the old University Observatory on the campus.

The Centre again had several telescopes set up each clear night at the Canadian National Exhibition, August 27 to September 11, and from one to six instruments were in use. A total of more than 6,000 visitors accepted our invitation to view the moon, Jupiter and other objects without charge and each was given a free copy of the "Sky Facts" leaflet which again was made available through the kind co-operation of The Toronto Daily Star.

The Centre is grateful to Mr. George T. Dale for his generous gift of a handsome three-inch equatorially-mounted refractor, made by Lloyd of Boston. This telescope was put to good use at both our summer Star Nights and at the Exhibition.

During the year expenditure of $100 was authorized to provide slow-motion controls for the Society's four-inch Cooke refractor. The work, done by Mr. Gerald Longworth of the David Dunlap Observatory staff, has turned the formerly almost-unmanageable telescope into one which will be of great value at observation meetings.

Our Telescope Makers Group, under the leadership of Mr. Raymond Pearce, continued to be active during the year with an enrolled 56 members working on or planning telescopes.

The Centre again made a gift of $100 to the General Council to more than cover the expense of refreshments at the Annual At-Home.

Among those of our members who passed away during the year, we note with regret the death of the Rev. C. H. Shortt, one of our senior members.

Subjects and speakers at meetings (held in the McLennan Physics Laboratory of the University of Toronto except where otherwise noted) follow:

January 30,—"The Origin of the Universe," by Dr. George A. Gamow, George Washington University. (Joint meeting with the Canadian Association of Physicists.)

February 24,—"Extended Period Weather Forecasting," by C. M. Penner, Meteorological Service of Canada.

March 9,—"The Life Story of a Meteoroid," by Dr. P. M. Millman, Dominion Observatory, Ottawa.

March 23,—"The Lure of Underground Treasure—Exploring the Earth's Crust by Geophysical Methods," by Dr. Lachlan Gilchrist.

April 6,—"Chinese Astronomy, Ancient and Modern," by Dr. C. S. Yu, former director of Nanking Observatory.

April 20,—"Other Worlds of the Sun's Family," by Miss R. J. Northcott.

May 14, June 11, July 9 and August 13,—Public "Star Nights" on the University of Toronto Campus.

May 28,—Special Members' Observation Night at old University Observatory on the campus.

October 12,—Annual Members' excursion to David Dunlap Observatory at Richmond Hill.

November 2,—Members' Night, old University Observatory. Film of solar prominences by Dr. C. S. Yu. Astronomical quiz conducted by R. W. Tanner.

November 16—"In Search of the North Magnetic Pole," by Paul H. Serson, Dominion Observatory, Ottawa.

November 30,—Members' Night, old University Observatory. Film of moon, eclipses and clouds by J. M. Grant. Quiz conducted by D. K. Norris.

December 14,—"Bode's Lost Planet," by Dr. Carl A. Bauer, University of Michigan Observatory. (Followed by Annual Meeting of Toronto Centre.)

FREDERIC L. TROYER, *Secretary*.

Ottawa Centre

During 1948 the membership increased from 71 members to 80. This is an encouraging trend and one which we hope will continue during 1949.

Four public meetings were held:

February 2,—Dr. C. S. Beals: "The materials of interstellar space."
February 16,—Dr. D. A. MacLulich: "Sun-spots and animal cycles."
March 4,—James Hargreaves: "Eclipse expedition to Brazil, May 1947."
March 18,—Dr. E. A. Hodgson: "Beyond the pick it is dark."
April 8,—Open House at the Dominion Observatory for members and friends. Afterwards refreshments were served at Observatory House through the kindness of Dr. and Mrs. Beals.

The sale of Handbooks continues in the capable hands of Mr. Matley. Two council meetings were held with an attendance of nine and eight respectively.

(Miss) C. B. Hicks, *Secretary*.

Hamilton Centre

During the year 1948 seven regular meetings were held in the Art Gallery, Hamilton, one meeting in May was held in the Planetarium at Central School in Forest Hill Village, Toronto, one Field Night, and two Council meetings to discuss the business of the Centre.

January 8,—George E. Campbell, M.A.: "A Layman Takes a Peek at Relativity."
February 5,—J. W. Watson, Ph.D., F.R.G.S.: "The Story of a Storm."
March 4,—E. G. MacKay, B.Sc., O.L.S., D.L.S.: "How the Surveyor Uses Astronomy."
April 1,—T. M. Norton: "An Evening of Moving Pictures."
May 6,—The May meeting of the Hamilton Centre was held in the Planetarium at Central School in Forest Hill Village, Toronto. Vernon Trott, M.A., of the school, demonstrated the apparatus.
June 14,—Field Night. The Hamilton Centre held its annual open house on the grounds of McMaster University. Ten telescopes, three of the reflector type, and seven refractors were used. Mr. W. T. Goddard very generously supplied doughnuts and coffee.
October 7,—Dr. Martin Johns: "Structure of the Atom."
November 4,—Dr. A. E. Johns: "Plumbing the Depths of Space."
December 2,—K. R. Stehling, B.A.: "Rocket Journies to Other Worlds."

Membership—Total membership 58, a net gain during the year of 11; and includes two life members.

George Murchie, *Secretary-Treasurer*.

Montreal Centre

The 1947-48 season was probably one of the most successful in the thirty years history of the Montreal Centre. Membership was well maintained and activities were varied and well supported. We are pleased to note the formation of a French-speaking Centre in this city, the Centre Français de Montréal.

Through the continued kindness of our good friend and honorary vice-president, Dr. A. Norman Shaw, and other authorities of McGill University, the Centre has held its regular meetings in the historic Macdonald Physics Building. A total of thirteen general meetings were held during the season with an average attendance of 73. These are fully recorded in the minutes of the Centre. The following guests addressed the Centre—Dr. John Ferguson, Dr. C. S. Beals, Dr. J. Stewart Marshall, Dr. C. S. Yu and Dr. Elton R. Pounder. In addition five members of the Council gave addresses at regular meetings.

Observation meetings continued to be held on Saturday evenings at the Ville Marie Observatory through the kindness of its owner, and our Director of Observations, Mr. DeLisle Garneau. The provision of a programme of short talks, demonstrations and discussions in addition to an increased amount of actual observation demonstrates the work and vitality of our Observation Committee.

Two visits, one to the Dominion Observatory in Ottawa and the other to the Springfield Telescope Makers Convention at the famous Stellafane, Vt., were made by parties of our members. The number making the latter trip was twenty-five. At the Convention one of our members, Mr. A. Vincent Whipple, won the award for "originality and ingenuity" with his six-inch reflector.

A very successful "star night" was held in June through the kind co-operation of the Mayor and other officials of the City of Westmount. The organizers of this event deserve the thanks of the Centre for their excellent work in this project of public education.

"Skyward" the Centre's monthly newsletter made an auspicious start during the year and is much appreciated by many of the members. This newsletter should do much toward creating and maintaining the esprit de corps of the Society in this city.

The Council of the Centre held five meetings during the year with an average attendance of fourteen.

As reported by our Treasurer, Mr. C. N. S. Yarnell, the finances of the Centre continue to be sound. It should be noted, however, that our present programme can only be maintained through the freewill gifts of our members and friends.

HENRY F. HALL, *Secretary.*

SEVENTH ANNUAL REPORT OF OBSERVATION COMMITTEE

The year 1948 was another year of great activity for the Montreal Centre. The attendance at Ville Marie Observatory, which in 1947 had shown at 1308 a marked increase over 1946, set a new record this year at 1400. Fifty-two Saturday meetings of the Montreal Centre resulted in a total attendance of 1199, special observation meetings, 43, and meetings of other groups, 158. Special groups included parties of Boy Scouts and other organisations.

In the realm of observations, we have the following to report:

Sun-spot observations. Seven members contributed a grand total of 338 observations over a period of 259 days and recorded 2789 groups with 23,691 spots. Included in these are Mr. DeKinder's 192 observations of 1519 sun-spot groups containing 13,210 spots. This continued solar activity was reflected somewhat in the aurora borealis. Miss Williamson, in charge of this section, reports that 13 members contributed 62 reports of 31 auroral displays; 79 estimates of variable stars were sent to the Recorder of the A.A.V.S.O. at Harvard College Observatory; 15 observations of Mars were made by 5 members who also contributed the same number of drawings of the planet; 19 observations and drawings of Jupiter were effected also and forwarded to Mr. Walter H. Haas at the University of New Mexico; 7 members timed and recorded the occultation of Mars by the Moon on February 23, 1948. Cmdr. G. R. Parry sent in a remarkable report on this phenomenon as observed from Port Maitland, N.S.

The Orionid meteors were observed by a group of 18 members, 60 meteors being recorded in three and a half hours. Plans were made to observe the Geminids and Perseids but unfavourable weather interfered. On April 18 members of the Council and Observation Committee motored to Ottawa for an afternoon session at the Dominion Observatory where they were received by Dr. Beals, Dr. Millman and other members of the staff.

The Fourth Annual Star Night was held in Westmount Park on May 12. Twenty-two telescopes were in operation throughout the evening and the event drew a crowd of over 1500 people. Members of the Committee also conducted a local Star Night at Valois last October with four telescopes in operation.

To wind up this series of events I have to mention the memorable trip of 25 members and friends to the Springfield Telescope Makers Convention at Stellafane, Vermont, on August 7, which culminated in the crowning success of Mr. A. Vincent Whipple who received recognition for his fine workmanship

in designing a telescope and mounting that won first prize. Speaking of telescope making, 14 of our members have been busy grinding mirrors and constructing mountings in the past year.

As regards the Messier Club, it is interesting to note the enthusiasm and activity of the 20 members who are vying for first place in locating the 103 nebulae and clusters catalogued by Messier.

In addition to the above, many of our members have been engaged in the past year in giving courses in astronomy to boy scouts, series of talks at summer camps and lectures to various groups of young people.

Copies of all documents are on file in the Observatory headquarters.

This report covers the interval from October 1, 1947 to September 30, 1948.

DeLisle Garneau, *Director of Observations.*

Report of the Librarian for the Year 1947-48

The past year was a very successful and active one for our Library as indicated by the increase in circulation of books and periodicals and by the number and quality of books, slides, etc. added through gifts and by purchase—the latter possible only through generous donations to the Library Fund.

Our slide collection, started last year, has been added to considerably by some of our members and also by the 100 slides of Dr. C. A. Chant's "Our Wonderful Universe" acquired through the generosity of the Province of Ontario Department of Education. Special mention should be made of the six transparencies made and donated to the Centre by Mr. Topham.

A complete list of books added to the Library during the past year is as follows:—

American Ephemeris and Nautical Almanac—1948.
Astronomy: Skilling and Richardson.
Astronomical Charts and Atlases: Brown.
Astronomy Charted: Wright.
Astronomy for Surveyors: Chapman.
Atoms and Electrons: Sullivan.
Introducing the Constellations: Baker.
John Couch Adams and the Discovery of Neptune: Jones.
R.A.S.C. Journal—1947.
Norton's Star Atlas and Telescopic Handbook: Norton and Inglis.
Other Worlds than This: Fontany.
Our Wonderful Universe (Copy 2): Chant.
Palomar Pictorial (Copy 2): Watson.
Photographic Giants of Palomar: Fossero and Porter.
Relativity: Einstein.
Star Names and Their Meanings: Allen.
Stars and Men: S. and M. Ionides.
Sun, Moon and Stars: Skilling and Richardson.
Sun, Stand Thou Still!: Armitage.

The Growth of Physical Science: Jeans.
The Naming of the Telescope: Rosen.
The New Astronomy: Langley.
The Royal Observatory, Greenwich: Jones.
This is the Moon: Cothren.
This Puzzling Planet: Brewster.
Time, Knowledge and Nebulae: Johnson.
When the Stars Come out: Baker.

C. M. Good, *Librarian.*

Victoria Centre

Membership—During 1948, 39 new members were added to the Centre. Eighteen members were lost for the following reasons: deceased, 1; left the city, 3; resigned, 2; dropped for non-payment of fees, 12. The net gain in membership of 21 persons leaves the Society with a total enrollment of 127 members. The Society has 5 life members, 9 junior members and 9 applicants for membership in the Centre as of January 1, 1949.

Meetings—The six regular meetings of the Centre have been held in the auditorium of the Provincial Normal School and Victoria College. During the summer a series of five lectures was sponsored by the Society. Sixty non-members of the Society took advantage of these meetings. Five of these are now regular members of Victoria Centre.

(Mrs.) J. H. Williams, *Secretary.*

London Centre

The London Centre held eight regular meetings and enjoyed one social get-together in the form of a picnic, during the year 1948.

January 9,—Dr. H. R. Kingston: "What's in the Sky for 1948." Prof. G. A. Woonton: "Radio and Optics."

February 20,—Rev. W. G. Colgrove: "Constellation Taurus." Dr. H. R. Kingston: "The Way of the Moon."

March 19,—Dr. G. R. Magee: "Constellation Gemini." Mr. P. J. Sandiford: "Spectroscopy."

April 16,—Dr. R. H. Cole: "Constellation Leo." Mr. E. E. O'Connor: "New Paths to New Planets."

May 21,—Dr. H. R. Kingston: "Interpreting Star Charts." Dr. A. J. Watt: "Constellation Coma Berenices." Mr. A. Emsley: "The Largest Eye in the World."

June 18,—Annual Picnic.
October 15,—Dr. H. R. Kingston: "Observer's Handbook." Dr. L. M. Spratt: "Constellation Cygnus." Mr. O. Kilburn: "Evolution of the Telescope."
November 19,—Rev. W. G. Colgrove: "Constellation Pegasus." Mrs. A. Davies: "The Origin of Suns."
December 17,—Annual Meeting, Election of Officers, Social Evening, Films.

A. EMSLEY, *Secretary.*

EDMONTON CENTRE

All regular meetings have been held in the Arts Building through the kindness of the University authorities. The annual meeting took the form of a dinner at the Corona Hotel. The attendance varied from 33 to 61 members and visitors with an aggregate of 301 people.

The Handbook talks have been given by Dr. Campbell, and short talks by Mr. Burt and Mr. Deane were given at several meetings.

The main papers have been as follows:

December,—Dr. Wm. Rowan: "Taurus the Bull."
January,—Dr. Max Wyman: "The Meaning of Relativity."
February,—Dr. Campbell: "Problem of Space Travel."
March,—David Kinloch and Peter Crockford: "An Imaginary Trip to Mars."
April,—G. W. Paul: "Radar and its Uses."
May,—Rex Gibson: "Lunar Mountaineering."
October,—Mr. Sheffield: "Comets."
November,—Dr. E. H. Gowan: "The Electromagnetic Spectrum."

The roll of the Centre now consists of 56 regular members and two associates.

E. H. GOWAN, *Honorary Secretary.*

CENTRE DE QUÉBEC

Au cours de l'année 1948, le Centre de Québec a tenu cinq réunions générales. Le 17 janvier, M. Albéric Boivin, professeur à la Faculté des Sciences de l'université Laval, a parlé des *Fusées et Possibilité des Voyages Interplanétaires*, devant une assistance nombreuse, parmi laquelle on remarquait un bon groupe d'étudiants à la Faculté des Sciences. Le travail de M. Boivin était une solide mise au point de la question des fusées, que nous avons eu la bonne fortune d'imprimer dans nos *Feuillets*. La séance du 3 avril a été consacrée exclusivement à l'audition de films astro-

nomiques, avec le concours du Service de Ciné-photographie de la Province. Le vendredi, 21 mai, avait lieu la séance préparatoire à la visite du seismographe des Sept-Chûtes, près de Sainte-Anne de Beaupré. L'instruction a été donnée par le Dr Lucien Massé, professeur de géophysique à la Faculté des Sciences. La visite du lendemain au seismographe a été un franc succès, malgré une forte averse qui a duré tout l'après-midi.

La réalisation de ces séances est dû pour une bonne part à M. Charles-Aimé Giroux, dont le travail en la circonstance consistait à réserver les services des conférenciers.

A la reprise des opérations, à l'automne, nous avons eu deux réunions générales. La première, tenue le 4 décembre, était un *Forum* sur la réforme du calendrier; MM. Frémont, Gagné et Pouliot ont contribué au succès de cette séance. Enfin, notre dernière réunion de l'année, celle du 11 décembre, nous a permis d'admirer la belle série de transparents, pour la plupart en couleur, que M. Descarreaux a réalisés avec le concours du Service de Ciné-photographie de la Province.

Le concours-questionnaire organisé par l'intermédiaire de la page d'astronomie de *L'Action Catholique*, a été le grand événement de l'année. Les concurrents se sont enregistrés au nombre de 345, soit beaucoup plus que ce qui était espéré. Les trente-trois meilleures copies ont été primées.

Les *Feuillets* de M. Descarreaux ont maintenu leur popularité des premiers jours; environ 2000 fascicules ont été demandés au cours de l'année. La réserve que le Comité du Télescope a mise de côté, comme produit de la vente de ces feuillets, a monté de 210 à 478 dollars durant la période qui nous occupe.

Notre objectif de membres a passé de 97 à 76, diminution due surtout à une règlementation plus sévère dans la perception de la cotisation annuelle.

A l'observatoire temporaire de la Tour Martello, au delà de 1600 visiteurs ont été accueillis. La 10 000e signature apposée dans notre régistre porte la date du 23 août de cette année. Les mesures d'étoiles variables se sont chiffrées à près de 600, et les observations du Soleil, à 157. Au cours de l'été, MM. Giroux et Bernier ont déterminé le méridien qui passe par le centre de la Tour Martello, et ont fait le graphique de l'horizon sensible de

ce point de vue. Ils ont aussi commencé une série d'observation de la turbulence qui, lorsqu'elle sera portée sur une période assez longue, s'averrera très pratique dans la détermination d'un site d'observatoire permanent. Toutes les occultations d'étoiles qui avaient des chances d'être observées à Québec, ont été calculées par la méthode graphique. Des 89 phases possibles, 12 seulement ont pu être observées—et chronométrées avec précision. Les autres ont été manquées, soit à cause des mauvaises conditions atmosphériques, soit à cause de la faiblesse de nos instruments.

M. Georges-Etienne Gagné, notre Président actuel, a continué ses précieuses observations de coïncidences de température. Partant du principe qu'il existe un cycle de température en accord avec la rotation synodique du Soleil, il cherche à en déduire une loi simple et applicable par tout le monde, qui permettrait de prédire le temps qu'il fera quatre semaines d'avance avec de bonnes chances de succès. Les chiffres que fournit M. Gagné ont d'autant plus de valeur qu'il n'accorde de coïncidence qu'à la suite d'un jugement très sévère. Pour la période de 27 jours, le pourcentage des coïncidences obtenu cette année a été de 36%, tandis qu'il était de 46% en 1947. Pour la période de 28 jours, le pourcentage est de 40%, sensiblement plus fort que celui de la période de 27 jours. Le même fait a été remarqué l'an dernier. La période de 28 jours avait donné un pourcentage de 55%, en 1947.

Comme les années dernières, notre Centre a bénéficié de l'aide de l'Académie des Sciences du Maryland, sous la forme habituelle du *Graphique du Ciel*. Des 3000 copies que nous avons reçues pour la distribution, il n'en restait qu'une centaine à la fin de l'année.

Enfin, pour terminer, signalons qu'au cours de l'année qui se termine nous avons fêté le cinquième anniversaire de la collaboration entre le Gouvernement de la Province de Québec et le Centre de Québec de la Société Royale d'Astronomie du Canada. Le Gouvernement était le seul de nos corps publics qui pouvait aider un mouvement comme le nôtre dans les circonstances, et il l'a bien compris. La société d'astronomie désire exprimer sa gratitude profonde au Gouvernement et souhaite que les bonnes relations actuelles durent encore longtemps, dans l'intérêt de la science et l'intérêt général.

Le Secrétaire-trésorier, PAUL-H. NADEAU.

Windsor Centre

The Windsor Centre held nine public meetings, one council meeting and one executive meeting in 1948. The public meetings were held in the Art Gallery, Willistead Library, through the courtesy of the Public Library Board and Miss Anne Hume, Secretary-treasurer. The June meeting and the executive meeting were held at the home of the President, Mr. D. C. Bawtenheimer. The Council met at the home of the Secretary.

Our meetings are announced in the local daily paper and also in the secondary schools. Each member receives a card, monthly, reminding him of the date of the next meeting. Interest in astronomy is being maintained and our meetings are well attended. At each public meeting one of our members describes the current astronomical events.

Our Centre continues to enjoy the co-operation of the Detroit Astronomical Society. The President, Mrs. Margaret Back, attends our meetings regularly and gives valuable help in securing outstanding speakers. Professor E. R. Phelps, Ph.D., Wayne University, our Honorary President, addressed our April meeting.

Several of our members visited the Cranbrook Schools, Birmingham, Mich., in June. There they joined with the Detroit Society in visiting the Cranbrook Institute of Science. The delightful tour was arranged by Mr. William Schultz, Jr.

The dates, speakers and topics of our public meetings follow:

January 20,—Lee F. McGee, B.A.: "The Properties of Optical Glass."
February 17,—Orren C. Mohler, Ph.D.: "Motion Pictures of the Sun." (Prepared at the McMath-Hulbert Observatory.)
March 16,—Robert T. Graham, B.T.C.: "Atomic Energy."
April 20,—E. R. Phelps, Ph.D.: "Latest Findings on Mars."
May 18,—Jack Evzovitch, B.S.E.E.: "The Milky Way."
June 22,—Frederick W. C. Jones, B.Sc.: "Motion Pictures in Colour, Yellowstone National Park." Observing and refreshments served by Mr. and Mrs. D. C. Bawtenheimer.
September 21,—Cameron Montrose, B.A.Sc.: "Time." Mrs. Margaret Back: "Visiting the Hale Observatory."
October 19,—E. G. Pleva, Ph.D.: "The Contributions of the Astronomical Sciences to Geographical Studies."
November 16,—Hugh Cunningham, B.A.: "Glancing Through Sky and Telescope." Annual Meeting, Reports and Election of Officers. Social Hour and Refreshments.

Russell Warwick, *Secretary*.

CENTRE FRANÇAIS DE MONTRÉAL

At the end of 1947 a number of French speaking members of the Montreal Centre decided to form a French section of the R.A.S.C. in Montreal. The proposal was well accepted by the General Council with the official name: "Centre français de Montréal".

The activities for 1947-48 for a starting year were quite numerous. A member of our Council, Rev. frère Robert, F.E.C., published in 1947, a book on elementary astronomy entitled: "Regard sur l'Univers", from which the author himself has drawn a series of 10 weekly public meetings on the following dates:

November 6,—"Immensité de l'Univers."

November 13,—"Les Lois du Mouvement diurne."

November 20,—"La Terre inlassablement tourne autour de son Axe."

November 27,—"Les grandioses Nébuleuses."

December 4,—"Notre foyer de lumière et de chaleur—Le Soleil."

December 11,—"Le grand spectacle des Éclipses."

December 18,—"La Lune, Reine des Nuits."

January 15,—"Les Astres innombrables de la Voie lactée."

January 22,—"Les Planètes."

January 29,—"La Simplicité des Lois du Système solaire."

February 12,—Dr. J. E. Gendreau: "Bombes atomiques dans les Cieux."

March 20,—Mr. René A. Robert, B.Sc.A.: "Le Spectroscope, Instrument merveilleux."

April 30,—Séance cinématigraphique sur "Sujets scientifiques."

May 20,—Dr. J. E. Gendreau: "Ondes dans les Airs."

In addition to these public meetings, several Council meetings were held, a Constitution Committee formed to prepare a Constitution to be presented at the next general annual meeting early in 1949.

Membership—As of December 1948, there are 48 paid-up members.

JOSEPH R. LEDUC, *Secretary-treasurer.*

FINANCIAL STATEMENTS

I. GENERAL TREASURER

GENERAL ACCOUNT

Bank Balance Dec. 31, 1947	$1,470.93	
Less transfer to Southam Press Fund	223.19	$1,247.74
Receipts		
Grants—Ontario	500.00	
Grants—Canada	1,620.00	
Fees	4,309.95	
Subscriptions	427.77	
Publications	1,505.51	
Bond interest	32.62	
Advertising	147.00	
Donation—Toronto Centre	100.00	8,642.85
		$9,890.59
Disbursements		
Publications	6,365.45	
Grants to Centres	1,097.50	
Stamps and stationery	489.55	
Salary	1,071.02	
Rent (13 months)	520.00	
General expense	188.34	
Exchange	106.07	
Insurance	25.50	9,863.43
		$ 27.16

LIFE MEMBERSHIP ACCOUNT

Receipts		Disbursements	
Bank balance Dec. 31, 1947	$356.33	Dominion of Canada bonds	$400.00
Donation	15.00	Brokerage and interest	2.72
Life membership fees (12)	300.00	Bank balance Dec. 31, 1948	268.61
	$671.33		$671.33

BUILDING FUND ACCOUNT

Receipts		Disbursements	
Bank balance Dec. 31, 1947	$ 607.43	Dominion of Canada bonds	$ 600.00
Bond interest	185.61	Brokerage and interest	4.08
Dominion of Canada bonds called	600.00	Bank balance Dec. 31, 1948	788.96
	$1,393.04		$1,393.04

SOUTHAM PRESS FUND

Receipts		Disbursements	
Bank balance Dec. 31, 1947	$223.19	Film (Solar Prominences)	$ 40.00
Bond interest	60.25	Chant Medal	35.00
		Safekeeping of bonds	9.15
		Bank balance Dec. 31, 1948	199.29
	$283.44		$283.44

BONDS AND DEBENTURES HELD BY R.A.S.C. AT IMPERIAL BANK

		Purchased	Sold	On hand	Yearly interest
Life members	$ 900.00	$ 400.00		$1,300.00	$ 32.62
Building fund	6,200.00	600.00	$600.00	6,200.00	185.61
Southam Press	2,050.00			2,050.00	60.25
	$9,150.00	$1,000.00	$600.00	$9,550.00	$278.48

BALANCE SHEET DECEMBER 31, 1948

Assets			
Cash in bank			
Imperial Bank of Canada		$1,284.02	
Invested in bonds			
Life members	$1,300.00		
Building fund	6,200.00		
Southam Press	2,050.00	9,550.00	
Accounts receivable		393.68	
Inventory of publications		750.00	
Prepaid insurance	25.50		
Prepaid rent	40.00	65.50	
Furniture and fixtures and library		4,724.00	
			$16,767.20
Liabilities			
Accounts payable		$1,350.00	
Surplus Dec. 31, 1947	$15,739.61		
Excess expense over revenue year, 1948	322.41	15,417.20	
			$16,767.20

Audited and certified correct:

H. M. Moncrief, *Certified Public Accountant.*

J. H. Horning, *General Treasurer.*

SUMMARY OF REPORT OF GENERAL TREASURER

The unsatisfactory condition of the Society's finances has not yet been remedied, although steps have been taken to improve matters. Revenue increase of $1,439.42 was overshadowed by expenditure increase of $1,934.99; the bank balance decreased from $1,247.74 to $27.16.

Good increases in fees, subscriptions and publications were experienced but these were more than offset by increases in publications, salaries and office expenses. No increases were received in grants in spite of the virtue of our claims.

For the future we hope for improvement from (1) the increase in fees and subscriptions to $3.00; (2) the Dominion grant for 1949 is increased by $380.00 to $2.000.00 (the amount the Society received 1908 to 1932). The governments of Ontario and Canada may again be asked for increases; (3) the continued printing of the JOURNAL in 6 issues per year instead of the regular monthly printing for 10 numbers per year.

Adverse financial factors will be (1) increased grants to Centres on account of increased numbers of members, (2) possible further increase in printing costs, (3) increase in office expense.

J. H. HORNING, *General Treasurer.*

II. REPORTS OF TREASURERS OF CENTRES

TORONTO CENTRE

RECEIPTS		DISBURSEMENTS	
Balance from previous year	$526.80	Rentals	$ 23.86
Grant from General Council	253.00	Postage, stationery, printing	42.25
Fee from Canadian National Exhibition	150.00	Expense re meetings	41.04
		Donation to General Society	100.00
		Transfer to Special Purpose account (see below)	450.00
		Balance carried forward	272.65
Totals	$929.80		$929.80

SPECIAL PURPOSE ACCOUNT

RECEIPTS		DISBURSEMENTS	
Transferred from Gen. Acct.	$450.00	Cartage (Exhibition)	$ 3.83
		Insurance (Exhibition)	9.00
		Plaques (Dale telescope)	8.64
		Repairs to Cooke telescope	95.00
		Balance carried forward	333.53
	$450.00		$450.00

T. H. MASON, *Treasurer.*

OTTAWA CENTRE

Receipts		Disbursements	
Balance from 1947	$ 51.01	Fees to General Treasurer	$138.00
Members' fees (61)	138.00	Expenses re meetings	101.25
Grant from General Council	57.00	1948 Handbooks	24.00
Donations	31.50	1949 Handbooks	24.00
Bank interest	.11	Balance carried forward	15.62
Handbook sales	25.25		
Totals	$302.87		$302.87

S. A. Mott, *Treasurer.*

HAMILTON CENTRE

Receipts		Disbursements	
Balance from 1947	$ 15.33	Rent	$ 17.50
Members' fees	102.00	Fees to General Treasurer	112.00
Grant from General Council	46.00	Postage	8.31
Bank interest	.08	Printing	13.61
1949 dues in advance	29.00	Expenses re meetings	2.00
Trip to Forest Hill	49.00	Exchange on cheques	.41
Sale of Handbooks	4.00	Miscellaneous	1.30
Sale of Pelican books	19.50	Buses	47.60
		Books	18.00
		Balance carried forward	44.18
Totals	$264.91		$264.91

George Murchie, *Treasurer.*

WINNIPEG CENTRE

Receipts		Disbursements	
Balance from 1947	$ 54.06	Rent	$ 10.00
Members' fees	91.00	Fees to General Treasurer	91.00
Grant from General Council	44.00	Stationery	3.42
Journal	.25	Postage	4.37
Donations	.50	Expense re meetings	2.00
Bank interest	1.65	Exchange on cheques	.15
		Miscellaneous	10.25
		Balance carried forward	70.27
Totals	$191.46		$191.46

Margaret E. Watterson, *Treasurer.*

VICTORIA CENTRE

Receipts		Disbursements	
Balance from 1947	$ 93.30	Rent	$ 30.00
Members' fees 1948	158.00	Fees to General Treasurer	100.00
Members' fees 1949	40.00	Stationery	6.73
Grant from General Council	123.50	Postage	15.03
Bank interest	1.19	Expense re meetings	17.16
Summer course	28.73	Exchange on cheques	.85
		Miscellaneous—	
		Library	13.00
		Express	1.52
		1947 Annual Dinner deficit	8.00
		Insurance	17.46
		Balance carried forward	234.97
Totals	$444.72		$444.72

(Mrs.) E. Williams, *Treasurer.*

MONTREAL CENTRE

Receipts		Disbursements	
Balance from 1947	$276.58	Rent	$ 46.00
Members' fees	549.00	Fees to General Treasurer	549.00
Grant from General Council	254.00	Stationery	93.53
Donations—		Postage	69.29
Library	26.00	Expenses re meetings	69.00
Equipment	6.00	Miscellaneous	10.99
General	71.20	Library	70.89
Bank interest	2.51	Equipment	41.15
Miscellaneous	.95	Star Night	19.88
		Balance carried forward	216.51
Totals	$1,186.24		$1,186.24

C. N. S. Yarnell, *Treasurer.*

LONDON CENTRE

Receipts		Disbursements	
Balance from 1947	$ 81.36	Fees to General Treasurer	$ 76.00
Members' fees	84.00	Postage	5.41
Grant from General Council	38.00	Exchange on cheques	.18
Bank interest	.35	Miscellaneous	.40
		Balance carried forward	121.72
Totals	$203.71		$203.71

A. Emsley, *Treasurer.*

VANCOUVER CENTRE

Receipts		Disbursements	
Members' fees	$114.00	Fees to General Treasurer	$114.00
Grant from General Council	67.00	Postage	1.12
Donations	5.00	Printing	4.00
Bank interest	.73	Expense re meetings	30.00
		Exchange on cheques	.15
		Deficit from 1947	26.66
		Balance carried forward	10.80
Totals	$186.73		$186.73

(Miss) G. W. Owen, *Treasurer.*

EDMONTON CENTRE

Receipts		Disbursements	
Balance from 1947	$ 33.13	Fees to General Treasurer	$122.00
Members' fees	131.00	Postage	1.25
Grant from General Council	30.00	Expense re meetings	20.95
Bank interest	1.16	Exchange on cheques	.15
		Miscellaneous	1.45
		Balance carried forward	49.49
Totals	$195.29		$195.29

(Miss) A. M. P. Smith, *Treasurer.*

CENTRE DE QUÉBEC

Recettes		Debourses	
Solde au l'décembre 1947	$ 2.90	Emprunt 1947	$ 85.00
Gouvernement Provincial 1947-8	300.00	Au Trésorier Général	150.00
Gouvernement Provincial 1948-9	300.00	Administration	292.31
Octroi R.A.S.C.	97.00	Timbres-poste	83.00
Cotisations	161.42	Observatoire	222.47
Dons	116.93	Remise au Comité du Télescope	95.48
Intérêt de banque	0.14	Solde en banque	50.13
	$978.39		$978.39

Paul-H. Nadeau, *le Trésorier.*

WINDSOR CENTRE

Receipts		Disbursements	
Balance from 1947	$ 39.66	Fees to General Treasurer	$125.00
Members' fees	119.00	Stationery	.67
Grant from General Council	34.00	Postage	3.72
Bank interest	.08	Printing	6.00
		Expense re meetings	15.50
		Exchange on cheques	.15
		Miscellaneous	8.67
		Balance carried forward	33.03
Totals	$192.74		$192.74

J. Evzovitch, *Treasurer.*

GUELPH CENTRE

Receipts		Disbursements	
Balance from 1947	$ 00.00	Fees to General Treasurer	$178.00
Members' fees	178.00	Stationery	2.76
Grant from General Council	54.00	Printing	31.73
		Expense re meetings	5.00
		Miscellaneous	8.68
		Deficit on trip to Toronto	9.40
		Deficit carried forward	3.57
Totals	$232.00		$232.00

S. B. MacKay, *Treasurer.*

CENTRE FRANÇAIS DE MONTRÉAL

Receipts		Disbursements	
Members' fees	$ 96.00	Fees to General Treasurer	$ 56.00
Donations	8.00	Stationery	3.44
Profit from books sale	23.40	Postage	2.26
		Printing	1.60
		Expense re meetings	9.00
		Miscellaneous	.10
		Balance carried forward	55.00
Totals	$127.40		$127.40

Joseph R. Leons, *Treasurer.*

The Royal Astronomical Society of Canada

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REVIEW OF PUBLICATIONS

Centennial Symposia, Harvard Observatory Monographs, No. 7. 6 × 9 ins. 385 pp., 1948. Harvard Observatory, Cambridge, Mass. Price $5.00.

The American Astronomical Society met in Cambridge during the Christmas holidays of 1946, to help Harvard University celebrate the completion of its first century of active telescopic research at Harvard Observatory. The meetings were very notable for many reasons. For example, a record number of astronomers and guests attended; Professor Russell gave the first Henry Norris Russell Lecture, an inspiring talk on the Royal Road of Eclipses; a portrait of Professor Shapley was unveiled; a session was held at the famous Harvard Computing Bureau; Professor Shapley braved a sleet storm to give a very thought-provoking address as President of the American Association for the Advancement of Science in Memorial Hall; and a well planned set of four symposia was arranged.

All those who attended the bewildering array of functions, and those not so privileged, will now welcome this collection of the two dozen papers which made up the symposia. Readers who have for years relied on the earlier volumes of the Harvard Monographs will be glad to add this new member to the series.

It is impossible in the limits of a review to summarize so many papers. As in the original symposia, they are divided into four groups, dealing with Interstellar Matter, Electronic and Computational devices, Eclipsing Binaries, and the Gaseous Envelope of the Earth. The symposia consisted of from three to eight separate contributions, by authorities from several countries, with interests all the way from pure observation to pure theory.

In each of the fields a sufficiently wide range of subject matter is included to serve as a good background for the very rapid changes in orientation which are taking place currently in these four active branches of study. The book should be of great use as a starting point for advanced students who wish to survey these fields. In particular it is appropriate to note that thirty pages of this volume are devoted

to the Henry Norris Russell Lecture. This paper, due to Russell's unique role as the pioneer of the study of eclipsing stars, to the excellence of the presentation, and the short selected bibliography, will undoubtedly form a royal road for many students.

This volume is well illustrated, printed and bound, to conform with the earlier volumes of the Harvard Monographs.

F. S. H.

MEETINGS OF THE SOCIETY

AT TORONTO

October 12, 1948.—The first regular meeting of the Toronto centre met at the Dunlap Observatory as the guests of Professor F. S. Hogg and the Observatory staff. Owing to cloudiness, the activities were confined to an inspection and explanations of the Observatory instruments, and to the proceedings in the lecture room. The chief item here was a talk by Dr. Chant on the great British astronomer, Sir William Herschel. The presence at this meeting of one of Sir William's direct descendants, Mrs. Tomes, added interest to the occasion. Dr. Chant, in an interesting, intimate way, showed the varied qualification for greatness possessed by Herschel, his helpful human nature, his surpassing industry and capacity, first in respect to long years as a musician, then as a student of astronomy and a maker of telescopes, a series of which he made, finally building a 40-foot instrument. He was outstanding in the illuminating interpretations he gave to his observations with the aid of these.

November 2 and November 30, 1948.—These were members' nights arranged to promote a more intimate sort of member-participating procedure.

A considerable number of pictures of sky phenomena had been posted about the room before the meetings and these were examined informally by the members who were asked to write down the proper name for each. The answers were given after due time, by the chairman, each person checking his own.

This was a sort of quizz number and was followed by another type later, which was conducted by a director giving questions or problems of astronomical significance in turn to the individuals of two contesting teams which had been chosen. In addition to the answers, other comments and explanations were added by any member, as occasion seemed to call for it. The younger members in particular were the more alert to this procedure.

November 16, 1948.—The Toronto centre, on this date, heard Mr. Paul H. Serson of the Dominion Observatory, Ottawa give an account of the expedition that he and some of his associates, made last year into the north polar region to discover the changes that had occurred in recent years in respect to the shifting magnetic north pole. The data they gathered indicate that it had shifted about 200 miles northward in the last fifty years. The Dominion Observatory since then has been taking steps to verify this and to prepare new maps and charts for the guidance of ships, planes and others travelling or living in those northern regions.

December 14, 1948.—Dr. C. A. Bauer of the University of Michigan gave a lecture on "Bode's Lost Planet." The speaker outlined past studies undertaken to show that there must have been in more or less recent astronomical times a planet at a place 2.8 times the earth's distance from the sun, in which area nothing has been discovered in modern times, except for asteroids and meteorites. Dr. Bauer is giving his account of recently revived studies of this problem, pointed out that the meteorites coming from that region showed a considerable amount of helium; that this amount indicated that some great impetus to the natural rate of radio-active disintegration in the cosmic universe must have taken place, for without this acceleration, the amount of helium referred to would indicate a greater age for the solar system than other evidences show. The explosion of a planet in that place, leaving only asteroids and meteorites would explain this impetus and the present remains.

J. R. Tuck, *Recorder.*

AT SASKATOON

September 27, 1948.—The first fall meeting of the Saskatoon Centre was held in the Physics Theatre at the University. The chairman outlined the pattern of the future meetings combining outdoor observing, guest speakers and becoming acquainted with the Handbook. After the acceptance of the slate of officers and the reading of the treasurer's report, Dr. Petrie gave a short talk on the angstrom, the light-year and the astronomical unit for those who were unfamiliar with them. The remainder of the meeting was spent at the observatory with Dr. White and Mr. Darby.

October 18, 1948.—The second observing meeting was held at the university. Dr. Petrie gave a short talk on apparent, mean, standard, and sidereal times. After a short description of the features of the moon which were to be seen, the group retired to the observatory.

November 9, 1948.—Dr. Currie of the Physics Department of the University gave a most interesting address on the eighth assembly of the International Union of Geodesy and Geophysics held in Norway this summer. He made note of the international co-operation which makes possible the support of studies of polar motion, gravity determination, seismology, and time determination.

Turning in detail to the subject of the Aurora Borealis, Dr. Currie first described the work of Störmer of Norway on the measurement of the altitude of the aurora. The work of Vegard on the auroral spectrum was noted. It has been found that the Hα, Hβ, and Hγ lines of the Balmer series are visible

during the early stages of an auroral display and slowly fade away even though there is no change in intensity of the display. He also described the auroral zone and its effect upon radio transmission. Dr. Currie concluded his address with a description of the correlation between the aurora borealis and other geophysical and solar phenomena.

December 6, 1948.—Dr. Harrington of the Physics Department addressed the group on the subject of nuclear physics. He explained the various types of nuclear reactions with the use of slides. After showing slides of the various accelerating machines used for obtaining high energy particles, Dr. Harrington explained how the changing magnetic field of the betatron was able to make electrons obtain very high energies for the production of X-rays. Dr. Haslam supervised the betatron demonstration which showed the action of X-rays in producing artificial radioactivity.

R. SMALL, *Recorder.*

AT EDMONTON

February 12, 1948.—The President called the meeting to order at 8:20 p.m. The minutes of the previous meeting were read and approved.

The Secretary read a letter from the Executive Commissioner of the Boy Scouts in Alberta asking for assistance in instruction and examination for the Starman's Badge. It was agreed that the Society ought to co-operate in this matter, and the President was authorized to nominate members who showed their willingness to assist. It was hoped that volunteers might come forward.

Dr. Campbell stated that a set of Dr. Chant's slides is being sent to this centre, donated by the Department of Education, Province of Ontario. The Handbook talk was given by Dr. Campbell. The chairman stated that at the Annual Council meeting in January it was agreed to have a series of 5-minute talks on the meaning of terms commonly used in the Handbook. Mr. Deane gave the first of these talks dealing in a very lucid manner with apogee, perigee, conjunction, opposition, quadrature, ascending and descending nodes.

The main paper was given by Dr. Campbell on the "Problem of Space Travel." Dr. Campbell discussed the many problems involved in rocket flight to the moon. In spite of the numerous assertions in the press and magazines that rocket flight would shortly be a fact, it became clear that there were still many problems that had not been solved. It also became clear that at least some of the protagonists of extra-terrestrial rocket flight were not aware of some of these problems. On the whole the meeting was convinced that travel to the moon was still part of a visionary future.

The meeting adjourned for refreshments at 10:10 p.m. There were 33 members and visitors present.

E. H. GOWAN, *Honorary Secretary.*

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(*Continued at bottom of next page*)

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1890-1948

The Society was incorporated in 1890 under the name of The Astronomical and Physical Society of Toronto, and assumed its present name in 1903.

For many years the Toronto organization existed alone, but now the Society is national in extent, having active Centres in Montreal and Quebec, P.Q.; Ottawa, Toronto, Hamilton, London and Windsor, Ontario; Winnipeg, Man.; Saskatoon, Sask.; Edmonton, Alta.; Vancouver and Victoria, B.C. As well as nearly 1300 members of these Canadian Centres, there are over 500 members not attached to any Centre, mostly resident in other nations, while some 140 additional institutions or persons subscribe to our publications.

The Society publishes a bi-monthly "Journal" containing about 350 pages and a yearly "Observer's Handbook" of 80 pages. Single copies of the "Journal" are 50 cents, and of the "Handbook," 40 cents.

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